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Soft bottom mollusc biocoenoses and thanatocoenoses in the Island of Lipari (Aeolian Islands)

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KEY WORDS: Biocoenoses, Thanatocoenoses, Soft bottoms, Aeolian Islands.

ABSTRACT Preliminary data on mollusc biocoenoses and thanatocoenoses sampled along the western side of the island of Lipari are discussed. The circalittoral soft bottoms are characterized by coarse sediments, terrigenous inputs and a high level of water movement. The biocoenosis of coarse sand and fine gravel under bottom currents (SGCF of PÉRÈS & PICARD, 1964) was identified in two stations. Some evidence of sedimentary instability was found in the other stations. The qualitative and quantitative composition of the mollusc thanatocoenoses was related to the occurrence of the various biocoenotic stocks: very high dominance values were found in the stock of species characteristic of the detritic biocoenoses complex. The observed differences between biocoenoses and thanatocoenoses are probably not related to the gradual modification of the biotope, but are the result of irregular variations in the sedimentary rate.

RIASSUNTO I fondi mobili circalitorali dell'Isola di Lipari sono stati indagati nel corso del programma 40% M.P.I. "Colonna d'acqua e fondo marino; relazioni tra le componenti del sistema nei mari siciliani". In particolare è stato effettuato uno studio comparativo su composizione e struttura dei popolamenti e delle tanatocenosi a molluschi su quattro campioni volumetrici, rappresentativi di altrettante stazioni. L'ambiente indagato è caratterizzato da sedimenti grossolani, prevalente sedimentazione terrigena e intenso idrodinamismo. Evidenze di destrutturazione sono state osservate in tutti i popolamenti a molluschi, anche quando riferibili a ben definite biocenosi (SGCF di PÉRÈS & PICARD, 1964), probabilmente in relazione ad instabilità del substrato. La composizione delle tanatocenosi a molluschi ha evidenziato, rispetto ai popolamenti, differenze di ordine qualitativo e quantitativo, soprattutto in ragione degli altissimi valori di dominanza dello stock dei fondi biodetritici. Si ritiene che le differenze riscontrate nell'organizzazione delle comunità attuali e pregresse siano principalmente da attribuire a irregolari variazioni nel regime sedimentario, piuttosto che ad una graduale modificazione del biotopo.

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INTRODUCTION

Biologists and palaeontologists have become increasingly interested in the relationships between biocoenosis and thanatocoenosis. With regard to this subject, a specific researchproject (TSM) has recently investigated detritic circalittoral biocoenoses of the Tuscan Archipelago and Pontine Islands (BASSO *et al.*, 1990). In these environments the scarce terrigenous input and high water movement produce feedback processes between organisms and the substratum; insular areas with volcanic activity, such as the Eolian Islands, have not been extensively studied.

In this paper, preliminary data on mollusc biocoenoses and thanatocoenoses investigated along the western coast of the island of Lipari, are shown and discussed. The results are a contribution to knowledge of soft-bottom communities in vulcanic insular environments, with regard to biotic stability.

MATERIALS AND METHODS

Samples were taken using a modified Van Veen grab, which allows the collection of $70 dm^3$ (BASSO *et al.*, 1990) of sediment from a surface of $0.4 m^2$.

Benthic malacofauna and the associated mollusc thanatocoenoses were studied on a volume of $50 dm^3$, retained on 1mm mesh sieves (PÉRÈS & PICARD, 1964), according to the method described by DI GERONIMO & ROBBA (1976). The complete lists of the living macrobenthic species, and of those of the mollusc thanatocoenoses, are given in a seperate data report (AA. VV., in press). All biocoenoses were identified and named according to PÉRÈS & PICARD (1964).

The textural features of the sediments were obtained by dry-sieving the fraction greater than 63 mm and using a sedimentation column for pelitic fractions (BUCHANAN & KAIN, 1971). As suggested by FOLK & WARD (1957) the most important statistical parameters (Mz, sk, s and Kg) were also examined. Calcium carbonate content was evaluated by NaOH titration after etching (BARNES, 1959).

Sampling location

Samples of benthos and sediment were collected on October 20 1989, in two different areas along the western coast of the island of Lipari (Fig. 1). The southern area (area A on the map), abeam of Punta Le Grotticelle, faces a steep and indented coast-which is markedly hollowed by small torrents. From the shore to a depth of 30m, rocky bottoms are common and partially covered by *Posidonia* seagrass; at 30-60 m depth, sandy and gravelly soft bottoms are prevalent. Two quantitative samples were taken at depths of 39m (station 1A) and 47m (station 2A). The northern area (area B in Fig. 1) is located near Punta Palmeto, a stretch of coast characterized by a high, sheer cliff, with a sharply sloping bottom. From the shore to a depth of 40m, rough hard bottoms are prevalent, whereas coarse sediments are common at greater depths. Quantitative sampling was carried out at two stations at 56m (st. 1B) and 59m (st. 3B).

Geographic al and bathymetric data of the sampling stations are reported in Table 1.

Station	Depth m	Geographic	Co-ordinates
1A	39	38°27.53 N	14°54.86 E
2A	47	38°27.49 N	14°54.81 E
1B	56	38°29.81 N	14°53.47 E
3B	59	38°29.89 N	14°53.72 E

Table 1. Sampling stations data.

RESULTS

The main granulometric features of the samples are shown in table 2. Sand is the prevailing class, with a maximum rate of 100% in station 1B. A small percentage of silt (14-16%) is present in sediment samples1A and 2A; a quantity of gravel (16%) was found in the sediments of station 3B. Sediments of samples 1A and 2A show the same grain size average (Mz = 2.8 F), similar to the value of sample 1B (2.26 F), but very different from that of 3B, which has a coarser texture (0.72 F). There are no marked differences in sk and kg values, showing symmetric and mesocurtic grain size distributions. Sediments are moderately sorted in stations 1A, 2A and 3B; only in station 1B are they mildly sorted, according to the highest textural homogeneity. Calcium carbonate content, entirely biogenic, is very low (>3,5%).

Thirty-one macrobenthic species of living molluscs (twenty-four Bivalves and seven Gastropods) were found in the samples (Tab. 3). Three species only were found in station 1B, 12-15 were found in the remaining stations. A high number of species (twenty-four) was found only once, twenty-two of them with one specimen only. *Abra prismatica* is the only species found throughout, although with a low number of specimens. The highest abundance values were observed in station 1A, due to the bivalve *Pteromeris minuta* and to the gastropod *Natica rizzae* (13 and 12 individuals respectively).

Species were given a bionomic attribute according to the literature data; six biocoenotic stocks were identified, excluding the eurytopic species with large ecological distributions (Lre). Dominance values of the stocks are shown in Table 4.

Divaricella divaricata is the sole species found which is characteristic of the fine, well-sorted sand biocoenosis (SFBC); the presence of this infralittoral species only in station 2A is accidental. The species of the coarse sand and fine gravel under bottom currents biocoenosis (SGCF) form the greatest part of the benthic mollusc assemblages in stations 1A and 3B; this is related to high hydrodynamism. The coastal detritic biocoenosis (DC) is well represented in all the stations (12-24% of dominance values); the very high value of dominance (80%) attained in the unstructured populations of station 1B is clearly not to be considered. Another species, *Timoclea ovata*, characteristic of the detritic biocoenoses complex (DC-DE-DL) was found in samples 2A and 3B; the higher frequency in station 2A (16% of dominance value) is justified by the presence of a percentage of silt in the sediment as *T. ovata* is a typical mixtophile species. In sample 3B (3%) it is probably an accidental species.

The record of characteristic preferential species of the terrigenous mud biocoenosis (VTC) in the 1A and 2A samples is also related to the silt fraction of the sediment. The dominance value of this stock is very low in both the stations (2% and 8% respectively).

Besides the stock of species which come from well-defined benthic biocoenoses, mollusc assemblages include some species which are "indicators" of sedimentary instability, and which have an important role in the make-up of the so-called Heterogenous Community (PE: Picard, 1965). These species are present in all four stations, but particularly in station 2A in which they make up almost half of the whole mollusc fauna.

The most significant species in this stock is *Corbula gibba*, recorded with 8 specimens in station 2A (32% dominance).

Natica rizzae was found in station 1A with 12 specimens, and was also included in this stock, although its role in the composition of the heterogenous community is still not well known.

As far as *habitus* and trophic roles, are concerned it was observed that the communities are almost entirely made up of infaunal species; filter feeders are prevalent, but there are also a low number of deposit and detritus feeders; carnivorous species are very rare, but twelve specimens (28.57% dominance value) of *Natica rizzae* were found in sample 1A. These observations do not concern station 1B, whose benthic populations are quite unstructured.

The mollusc thanatocoenoses presented 205 species (105 Gastropods, 3 Scaphopods and 97 Bivalves). The complete list of molluscs, with their respective abundances and dominance values, is published in the data report mentioned above (AA.VV., in press). The highest number of species (166) was found in station 1A, the lowest in station 1B (49), the same applies for the number of specimens (2590 and 233 respectively).

As regards the biocoenoses, a bionomic significance was also attributed to the single species of the mollusc thanatocoenoses, in accordance with the to literature. The various stocks identified were put into 8 groups, including the stock of the species without any specific ecological role (Lre). For example, the characteristic exclusive and preferential species of the *Posidonia* meadows (HP) were united with those of the photophilic algae biocoenosis (AP) due to the much higher incidence of the former and to the high number of species which live in both biocoenoses. In the same way, species characteristic of terrigenous mud (VTC), species of the circalittoral-bathyal transition and those typical of the upper horizon of the bathyal zone were merged. Furthemore, a stock including all midlittoral and infralittoral species of the soft bottom was created.

The numerical relationships between the various stocks identified in the four samples are shown in Figure 2. We observed that station 1A is mainly characterized by the high incidence of the AP-HP stock (13.49%), which was present as a minimum percentage (0.14% in 2A) in other samples. This entirely allochthonous stock originates from the seagrass meadow of area A. Another allochthonous stock composed of various midlittoral and infralittoral species is present in all stations (max 21.37% in 1A). The autochthonous component is dominated by species characteristic of detritic biocoenoses. Two stocks were identified. The first involves species characteristic of the coastal detritic biocoenosis (DC), which include the few coralligenous species found; the highest values are to be found in the two deeper stations. The second stock includes characteristic preferential species of the coastal detritic (DC) and muddy detritic bottom (DE) biocoenoses. Except in station 1A, in which the dominance is only 14.59%, this stock is by far the most important, and in the deeper stations (3B and 2A) it alone constitutes more than half the thanatocoenoses (59.5% approx). It must also be emphasized that the high incidence of this stock is almost entirely due to *Timoclea ovata*, present with high dominance values, above all in the two deepest stations (43-45%). Another group of species related to environments with a high level of hydrodynamism was found in all stations with dominance values ranging from 5.6% (station 1B) to 13.5% (station 1A). The stock attributed to the biocoenosis of coarse sand and fine gravel under bottom currents, is entirely autochthonous only in the two deepest thanatocoenoses (2A and 3B). On the other hand, a notable allochthonous component is present in the two more superficial samples, especially in sample 1 where the relationship between soft bottoms and *Posidonia* meadows (channels of "intermatte") seems to be important.

Finally, a small group of species characteristic of the terrigenous mud biocoenosis, together with a few others with bathyal affinities, is present in the four stations. Its incidence is generally very modest, with dominance values lower than 1%, except in station 1B where it exceeds 9%. In station 1B the entirely autochthonous stock is to be considered with the presence of a significant fine sediment fraction.

The species indicating bottom turbidity,which are not very numerous, have higher dominance values in the shallowest stations (5.7-10%) than in the deepest ones (about 3.5%).

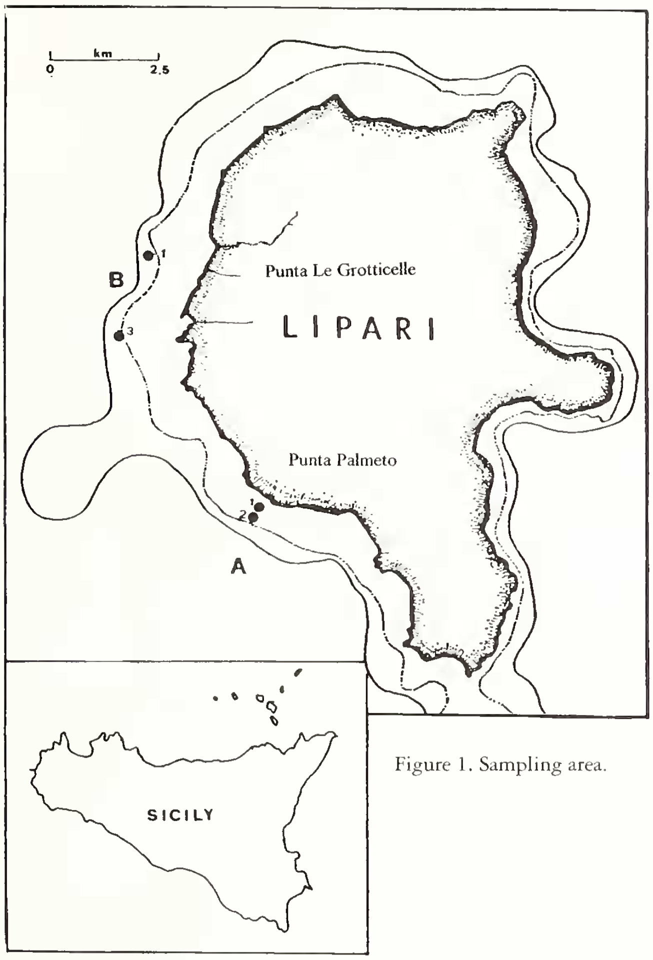

Figure 1. Sampling area.

All the stocks described here include a high number of species, the majority of which are present as a limited number of specimens. Excluding the autochthonous stocks, only 20 species have dominance values higher than 1% in at least one sample (Table 5). Moreover a clear difference is noted between the high dominance values of *Timoclea ovata* and *Cerithidium submammillatum* the much lower values of all the other species.

DISCUSSION AND CONCLUSION

The granulometric and faunistic data of this study have allowed the identification in stations 1A and 3B of molluscan assemblages wich belong to the biocoenoses of coarse sand and fine gravel under bottom currents (SGCF). In both stations, it can be hypothesized that there are conditions of relative sedimentary instability due to the presence of specific secondary stocks (PE) related to the poor trophic structure of the community. On the other hand, differences in the specific composition of the two stations are to be attributed to their bathymetric locations and different relationships to the adjacent biotopes. The instability factor noted in these two stations seems to be even more marked in station 2A, the populations of which are made up of a small number of characteristic species of different biocoenoses (SFBC, DC, DC-DE-DL and VTC), numerically subordinate to the opportunist species stock (PE). Finally in station 1B, the limited number of species and individuals show a marked involution of the community.

The quali-quantitative composition of the mollusc thanatocoenoses show, with respect to the biocoenoses, a different occurrence of the various biocoenotic stocks considered. These differences are only partly explained by the presence of a large allochthonous component in the thanatocoenoses, which is easily identifiable on both a deductive basis (the autoecological characteristics of the species) and an objective one (the state of conservation of the specimens). All this leads us to suppose that the present benthic communities were preceded, in a recent past, by different ones whose salient appearance was lent, to a different extent, by species characteristic of detritic environments. The exact temporal distance between the two types of community cannot be quantified here, although it certainly comes withih the evolution times of benthic marine mesoecosystems (PICARD, 1985), but on a smaller scale. This hypothesis is also supported by the sedimentary characteristics of the site, which is fed intensively by easily-eroded piroclastic deposits while the high acclivity of the bottom, the low specific weight of the sediments and the intensive hydrodynamism all contribute to determining a more or less marked condition of sedimentary instability.

Thus, in our opinion, the observed differences between the biocoenoses and thanatocoenoses should not be interpreted in terms of a gradual modification of the biotope but as different manifestations of a single phenomenon. Once again, with reference to the composition of the mixed detritic stock, we observe that its dominant role within the thanatocoenoses is almost entirely due to only two species, *Timoclea ovata* and *Cerithidium submammillatum*, whose dominance is much greater than that of any other species present in the thanatocoenoses. As the stock is entirely autochthonous, these species must obviously at some time have had the possibility of forming luxuriant populations. An alternative hypothesis is that these species were the only ones among all those found to have populated the biotope in a significant and continuous way. We find the latter hypothesis less plausible, given that the species with the highest dominance values in the biocoenoses (including *Timoclea ovata*) are also well represented in the thanatocoenoses, while *Cerithidium submammillatum* is absent from the biocoenoses, even though it is extremely abundant in the thanatocoenoses. Moreover, what is known about the autoecology of the two mixtophile species suggests that both might have profited from a phase characterized by a higher rate of fine sedimentation.

In conclusion, these data contribute to characterizing an environment with a high level of hydrodynamism, a more or less marked sedimentary instability and, consequently, a variability in the benthic communities in short and medium time periods. This variability, which can be hypothesized on the basis of the poor structure of the mollusc assemblages, is also documented in thequalitative and quantitative composition of the thanatocoenoses, despite the rather non-conservative sedimentary environment. Recent investigations on deep benthic assemblages (ALBERTELLI *et al.*, 1995; DI GERONIMO *et al.*, 1995) also show a very scanty presence of living organisms, notwithstanding a much more diversified tanathocoenosis. In this way we believe that environmental instability could be relatively common in the insular biotope of the Eolian Islands.

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Station	Gravel %	Sand %	Silt %	Mz Φ	Sk	σ	Kg
1A	0.73	83.23	16.04	2.87	-0.26	1.19	0.96
2A	1.79	83.32	14.88	2.82	-0.43	1.30	1.12
1B	0	100	0	2.26	0.12	0.92	0.95
3B	16.01	83.9	0	0.72	0.28	1.77	0.86

Table 2. Main granulometric data.

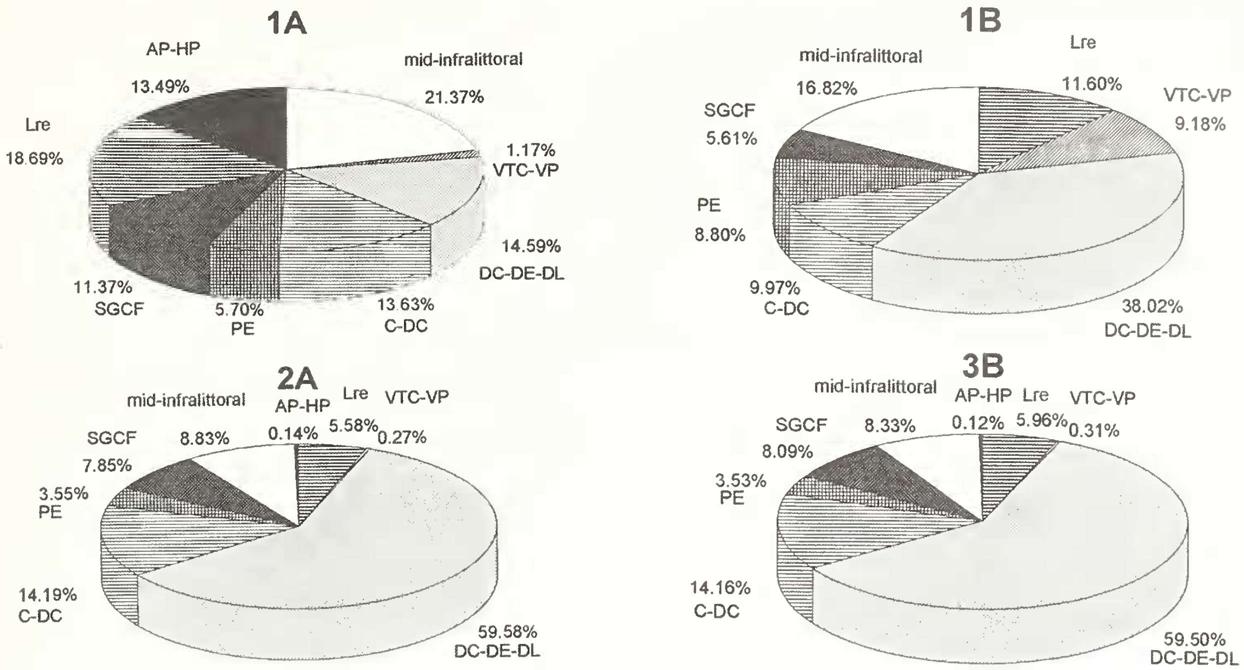

Figure 2. Diagrams of biocoenotic stocks in mollusc taxocoenoses.

Station	1A	2A	1B	3B				
Species	**Abb**	**Dom**	**Abb**	**Dom**	**Abb**	**Dom**	**Abb**	**Dom**
Turritella communis RISSO			1	4				
Caecum trachea (MONTAGU)							1	3:23
Bittium reticulatum (DA COSTA)							1	3:23
Calyptraea chinensis (L.)							5	16.13
Natica (Tectonatica) filosa PHILIPPI	12	28.57						
Cylichna cylindracea (PENNANT)	1	2:38						
Roxania utriculus (BROCCHI)			1	4				
Nuculana (Lembulus) pella (L.)			3	12	1	20	2	6:45
Glycymeris glycymeris (L.)							1	3:23
Neopycnodonte cochlear (POLI)							1	3:23
Lucinella divaricata (L.)			1	4				
Myrtea (M.) spinifera (MONTAGU)							1	3:23
Laptaxinus subovatus (JEFFREYS)	1	2:38						
Diplodonta rotundata (MONTAGU)			1	4				
Pteromeris (Coripia) minuta (SCACCHI)	13	30.95					7	22.58
Digitaria digitata (L.)	2	4.76						
Astarte fusca (POLI)			1	4			1	3:23
Gonilia calliglypta (DALL)							4	13
Goodallia triangularis (MONTAGU)	3	7.14			1	20		
Parvicardium minimum (PHILIPPI)			1	4				
Tellina (Moerella) donacina L.			1	4				
Tellina (Moerella) pygmaea LOVEN	4		9.52				3	9.68
Psammobia (P.) fervensis (GMELIN)	1	2:38	1	4				
Abra (A.) prismatica (MONTAGU)	1	2:38	1	4	3	60	1	3:23
Clausinella fasciata (DA COSTA)							1	3:23
Timoclea ovata (PENNANT)			4	16			1	3:23
Gouldia minima (MONTAGU)			1	4				
Callista chione (L.)	1	2:38						
Corbula (Varicorbula) gibba (OLIVI)			8	32			1	3:23
Thracia (T.) villosiuscula (MC GILLIWRAY)	2	4.76						
Lyonsia (L.) norvegica (GMELIN)	1	2:38						

Table 3. Mollusc taxocoenoses abundance and dominance values.

Station	SFBC	SGCF	PE	DC	DC-DE-DL	VTC	Lre
1A	0	49.99	28.57	12	0.00	2:38	7.14
2A	4	0	44	24	16	8	4
1B	0	0	20	80	0	0	0
3B	0	45.17	9.68	16.14	3:23	0	22.59

Table 4. Biocoenotic stocks in mollusc taxocoenoses.

Station	1A		2A		1B		3B	
Species and related biocoenotic stocks	Abb	Dom	Abb	Dom	Abb	Dom	Abb	Dom
SGCF								
Gonilia calliglypta (DALL)	3	0.12	63	4.16	5	2:16	68	4.02
Tellina (Moerella) pygmaea LOVEN	167	6.45	30	1.98	-	-	31	1.83
Psammobia (Psammobella) costulata TURTON	38	1.47	14	0.93	-	-	16	0.95
Pteromeris (Coripia) minuta (SCACCHI)	19	0.73	-	-	-	-	48	2.84
PE								
Corbula (Varicorbula) gibba (OLIVI)	96	3.71	17	1.12	8	3:45	20	1.18
Nuculana (Lembulus) pella (L.)	18	0.69	25	1.65	7	3:02	26	1.54
Tellina (Tellinella) distorta POLI	11	0.42	-	-	3	1.29	1	0.06
DC								
Tellina (Moerella) donacina L.	160	6.18	30	1.98	9	3.88	31	1.83
Goodallia triangularis (MONTAGU)	218	8.42	48	3.17	2	0.86	25	1:48
Limatula subauriculata (MONTAGU)	48	1.85	99	6.54	-	-	105	6.20
Limatula gwyni (SYKES)	10	0.39	6	0.04	6	2.56	15	0.89
Plagiocardium (Papillocardium) papillosum (POLI)	12	0.46	5	0.33	3	1.29	5	0.30
DC-DE-DL								
Jujubinus montagui (W. WOOD)	-	-	22	1.45	2	0.86	24	1:42
Timoclea ovata (PENNANT)	101	4	681	45.01	87	37.5	729	43.06
Cerithidium submammillatum (DE RAYNEVAL & PONZI)	137	5.29	185	12.23	5	2:16	225	13.29
Hyalopecten (Similpecten) similis (LASKEY)	35	1.35	22	1.45	3	1.29	23	1.36
Glans (Centrocardita) aculeata (POLI)	71	2.74	2	0.13	-	-	3	0.18
VTC-VP								
Yoldiella philippiana (NYST)	1	0.04	-	-	3	1.29	-	-
Kelliella abyssicola (FORBES)	-	-	-	-	4	1.72	-	-
Alvania (A.) testae (ARADAS e MAGGIORE)	-	-	-	-	3	1.29	-	-

Table 5. Main species of mollusc thanatocoenoses (abundance and dominance values).

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